# Stormwater Research Needs Identified in Conjunction with Updating WSDOT's Highway Runoff Manual

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Keywords: stormwater, research, best management practices, highway runoff, runoff treatment, flow control

**Abstract**. The Washington State Department of Transportation completed a major revision and update of its Highway Runoff Manual (HRM), first published in 1995. The need for the revision was triggered by several factors, including incorporating recent advances in the science of stormwater management, adding new best management practices (BMPs), and meeting state regulatory requirements. In regard to the latter factor, the HRM had to be revised to maintain equivalency with the Washington State Department of Ecology's (Ecology) stormwater management manuals for western and eastern Washington. These manuals include new requirements for use of continuous flow modeling, matching peak duration as well as peak flow for storm events, a new flow control (water quantity) standard, enhanced runoff (water quality) treatment for removal of dissolved metals, and oil and phosphorus control in select locations.

The revision effort took approximately two years and the cost approached $1 million. The revision work was accomplished using an interdisciplinary team of WSDOT employees and Washington State Department of Ecology and local government representatives; as well as consultants for completing discrete tasks for new content.

The revised Highway Runoff Manual was published in March 2004. It applies statewide, reflects the best available science and engineering approaches, and expands flow control options. The HRM provides guidance for avoiding and mitigating water resource impacts, choosing stormwater management solutions that consider the watershed context of the project, analyzing offsite treatment options, stormwater retrofits, integrating stormwater planning and design into the project development process, and supporting compliance with the Endangered Species Act. New BMPs in the 2004 HRM for runoff (water quality) treatment include the Ecology embankment/ditch (approved for Conditional Use), compost-amended vegetative filter strips, oil containment boom (Pilot Use), bioinfiltration Swale, and the StormFilter™. Guidance is provided for using low impact development (LID) BMPs such as natural and engineered dispersion; site suitability criteria, analysis, and design for infiltration; soil amendment BMPs; and permeable pavement. Additional BMPs for flow control in the new HRM include off-site options, impervious surface tradeoffs, LID flow control “credits”, and natural and engineered dispersion.

One focus of the revision was to incorporate new BMPs that are effective, low cost, and fit well in a linear transportation corridor. These BMPs include those that utilize infiltration, low impact development, engineered roadsides, and treatment within an amended surface soil profile. WSDOT was able to achieve conditional approval from Ecology for some of these BMPs, while others require more research and monitoring for general approval. Of particular interest is investigation to account for the flow control benefits of dispersion and infiltration BMPs whose primary function is runoff treatment.

Before going into the research needs, the presentation features one linear BMP developed by WSDOT that has worked quite well. It is the Ecology Embankment, which is a flow-through runoff treatment BMP developed for use where available right of way is limited. The BMP can be sited on both highway side slopes and in medians. This BMP uses filtration through a pervious, alkalinity-generating treatment medium–called the Ecology Mix–that was developed to remove suspended solids and soluble metals from highway runoff through physical straining, ion exchange, carbonate precipitation, and bioinfiltration. In NRCS Group A or B soils, it is highly likely that this BMP will infiltrate all water entering it for all but the most extreme storms. For application in Group C or D soils, a perforated underdrain is included so that treated runoff can be conveyed to a receiving water body or to a flow control BMP, if needed.

Although there are many research needs associated with highway runoff, the following are considered priorities and were included in the presentation:
**Infiltration and natural or engineered dispersion**. Natural dispersion uses existing soils and landforms, if available, to disperse runoff. Engineered dispersion uses modifications to native drainage systems to improve runoff infiltration and retention. These modifications could include soil amendments, level spreaders, native plants, storage layers, soil ripping, and French drains. Research is needed to account for both the water quality and flow control benefits provided by dispersion and infiltration as runoff sheet-flows off the roadway into areas of vegetation, prior to entering surface or ground water.
**Roadside Low Impact Development (LID) approaches for flow control**. How can LID systems be accurately modeled (i.e., hydrologic losses quantified) and designed so that end-of-pipe stormwater control systems can be accurately sized? What are the flow control benefits of: compost-amended soils, compost blankets, landscaped fill slopes, vegetated filter strips, and bioretention areas; and restoring degraded lower-order creeks with energy dissipaters and larger riparian zones for use as conveyance channels instead of using localized detention ponds?
**Flow control in highly urbanized environments**. This research need stems from the question of what is the ecologic value of detention facilities for flow control, in ultra urban watersheds with highly degraded and extensively hydro-modified stream systems? Research is needed to determine if an impervious surface threshold is scientifically valid, and if so, what is the appropriate threshold (expressed as a percentage of total watershed area) above which environmental benefits of flow control begin to diminish significantly; and how does this threshold vary with watershed type (e.g., climate, geology, stream gradient and density, basin scale)? It is thought that over a period of time after urbanization, stream channel form adjusts and a stable equilibrium is achieved. The Department of Ecology recognizes this process in a new flow control standard for use in drainage basins that have had at least 40% Total Impervious Area for 20 years.

**Runoff (Water Quality) Treatment Thresholds**. In Washington State, there is a requirement for "Enhanced" runoff treatment for water quality, to increase metals removal from highway and arterial runoff. Research is needed to determine if there are "threshold" traffic densities (e.g. average daily traffic–ADT) below which "Basic" runoff treatment is adequate; what pollutants in highway runoff are highly correlated with ADT, and which are not; and to determine if there are better indicators than traffic volume to trigger the need for enhanced treatment. For example, how much of a factor is off-site contributions such as atmospheric deposition.